***Claim Objections***

The reformatting of the Claims 1-15 has been carried out to overcome the Objections in Claims 4, 5, 8, 9, 12, and 13 on page 2 of the Office Action.

***Remarks***

No additional Claims have been added nor have been any Claims canceled with this response. Therefore, Claims 1-22 are "currently pending claims."

***Claim Rejections - 35 USC § 112***

The Examiner rejects Claims 16-22 under 35 U.S.C. 112, first paragraph, because the specification does not mention the chemical formula of "etching gas containing $C_nF_{2n-2}$, in which, n = 4 or 5." This is respectfully denied.

New Claim 16 has been added to draft an allowed generic Claim as provided by 37 CFR 1.141. Claims 17-22 depend from new Claim 16. Claim 16 recites etching gases $C_5F_8$ and $CHF_3$ and $C_4F_6$ and $CHF_3$ claimed by currently pending Claims 1 and 9, using the <u>generic wording</u> $C_nF_{2n-2}$, wherein, n = 4 or 5. This expression is very

common for the person skilled in the art. The formula $C_nF_{2n-2}$, wherein n = 4 or 5, clearly stands only and exclusively for $C_5F_8$ and $C_4F_6$.

$C_nF_{2n-2}$, wherein n = 4 stands for $C_4F_6$,

$C_nF_{2n-2}$, wherein n = 5 stands for $C_5F_8$.

It is therefore believed that new claims 16 to 22 contain subject matter, which is described in the specification.

***Claim Rejections - 35 USC § 102***

The Examiner rejects Claims 1-4, 6-7, 9-12, 14, 16-19 and 21-22 under 35 U.S.C. 102(a) and/or (e) as being anticipated by Kim et al. U. S. Patent No. 6,316,349 (hereinafter called "Kim et al.").

The Examiner recites regarding independent Claims 1, 9 and 16 col 9, lines 15-21 of Kim et al. and asserts that Kim et al. discloses the use of gas containing $C_5F_8$ and $CHF_3$ or $C_4F_6$ and $CHF_3$ when n = 4 or 5 for plasma-etching the oxide-insulating layer. This is respectfully denied.

Applicants assert that Kim et al. teach a method for forming contacts of a semiconductor device using an oxidized silicon-rich

nitride film as an etch barrier film. Kim et al. mention in col. 9, lines 15-21 a C-H-F based gas selected from the group consisting of $C_2F_4$, $C_2F_6$, $C_3F_6$, $C_3F_8$, $C_4F_6$, $C_5F_8$, $C_4F_{10}$, $CH_3F$, $C_2HF_5$, $C_2H_2$, $CH_2F_2$, $C_xH_yF_z$ (x + y = 2, 3, 4, 5; z = 4, 6, 8, 10) and mixtures thereof. Kim et al. mention in col. 15, line 35 a C-F-based plasma, such as $C_4F_8/CH_2F_2$ and in line 43 $C_3F_8$ or $C_5F_8$, in which a C-H-F based gas may to the carbon rich fluorine gas. However, Kim et al. do not teach $CHF_3$ as an etching gas. Further, Kim et al. do not mention etching gas containing $C_5F_8$ and $CHF_3$, $C_4F_6$ and $CHF_3$ or $C_nF_{2n-2}$ and $CHF_3$, wherein n = 4 or 5 according to independent Claims 1, 9, and 16.

The present invention according to independent Claims 1, 9, and 16 is therefore not anticipated by Kim et al. Since independent Claims 1, 9, and 16 are not anticipated by Kim et al. it is believed that the dependent Claims 2-8, 10-15 and 17-22 are not anticipated by Kim et al. as well.

***Claim Rejections - 35 USC § 103***

The Examiner rejects Claims 5, 13, 15, and 20 under 35 U.S.C. 103(a) as being unpatentable over by Kim et al. U. S. Patent No. 6,316,349 (hereinafter called "Kim et al.") and in view of Thei et

al. U.S. Patent 6,335,249 (hereinafter called "Thei et al."). The Examiner asserts that Kim et al. teach using $C_5F_8/CHF_3/Ar$. This assertion is wrong as pointed out above. Kim et al. mention a long list of C-H-F and C-F based gases, but have to leave out $CHF_3$.

Kim et al. teach away from the present invention. Since Kim et al. leave out $CHF_3$, the implication for a person skilled in the art is that $CHF_3$ and $CHF_3$ combined with $C_5F_8$ or with $C_4F_6$ does not work. Applicants agree with the second Examiner's assumption that Kim et al. fail to teach forming an etch stop layer of oxidized silicon-rich nitride layer.

***Claim Limitations***

The Claim limitations of independent Claims 1, 9, and 16 are:

A method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, comprising the steps of:

forming a nitride etching stop layer over the gate electrodes and the semiconductor substrate;

forming an oxide insulating layer on the nitride etching stop layer; and

plasma-etching the oxide insulating layer by an <u>etching gas</u>

containing ($C_4F_6$ and $CHF_3$)/($C_5F_6$ and $CHF_3$)/($C_nF_{2n-2}$ and $CHF_3$), wherein n = 4 or 5, so as to form a self-aligned contact hole between the pair of gate electrode.

Thei et al. mention an etching gas such as $CF_4$ and $CHF_3$, see col. 5 lines 61 and 62. Thei et all. do not teach or suggest using $CHF_3$ combined with $C_5F_8$ or with $C_4F_6$.

The Examiner further rejects Claims 1-4, 6-7, 9-12, 14, 16-19 and 21-22 under 35 U.S.C. 103(a) as being unpatentable over Kim et al. and in view of Prall et al U. S. Patent No. 6,337,244 (hereinafter called "Prall et al.").

Applicants assert that Prall et al. teach one preferred specific gas included a combination of only $C_4F_8$, $CH_2F_2$ and argon, see col. 6, lines 36 and 37. However, such gases are exactly the conventional etching gases shown on page 2, lines 3-25 of the description. As Applicants point out in the description, this gas combination ($C_4F_8/CH_2F_2$) provides lower etching selectivity concerning the bottom of the underlying etching stop layer, such that the surface of semiconductor substrate is over etched.

Applicants submit enclosure 1 showing a result of scanning electron microscopy (SEM) for a self-aligned contact (ASAC) hole

etched by such specific etching gas including a combination of $C_4F_8$, $CH_2F_2$ and argon. The surface of the semiconductor substrate is over etched.

Applicants further submit enclosure 2 also a result of scanning electron microscopy (SEM). In addition, the etching stop layer near the corner part is over etched, because the etching gas combination of $C_4F_8$, $CH_2F_2$ and argon provides insufficient etching selectivity concerning the corner part of the underlying stop layer.

Prall et al. do not teach or suggest using $CHF_3$ combined with $C_5F_8$ or with $C_4F_6$.

***Prima Facia Case of Obviousness***

To establish a *prima facia* case of obviousness, three criteria must be met according to Manual of Patent Examining Procedure (MPEP) 2142.

- First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the

reference or to combine reference teachings.

- Second, there must be a reasonable expectation of success, if the references are combined.
- Finally, the prior art reference Kim et al (or combined with Thei et al. or Prall et al.) must teach or suggest all the claim limitations.

Kim et al (or combined with Thei et al. or Prall et al.) do not teach or suggest all the claim limitations. Kim et al. do not teach the use of $CHF_3$. Prall et al. teach the combination of $C_4F_8$, $CH_2F_2$ and argon and Thei et al. teach the use of $CF_4$ and $CHF_3$.

There is no motivation to combine Kim et al. with Thei et al. or Prall et al. for the person skilled in the art, since Kim et al. teach using a long list of gases but not $CHF_3$.

There is no reasonable expectation of success by combining Kim et al. with Thei et al. or Prall et al., since the person skilled in the art would be motivated to use a combination of $C_4F_8$, $CH_2F_2$ and argon and try to avoid over-etching by well known measures, such as controlling the etch time.

The well-known disadvantages of the etching gas combination of

$C_4F_8$, $CH_2F_2$ mentioned by Kim et al. and Prall et al. could surprisingly be overcome only by the present invention. The method of the present invention equalizes the etching rate at the corner and the bottom of the etching stop layer by the etching gas containing $C_nF_{2n-2}$ and $CHF_3$, wherein n = 4 or 5. Applicants submit enclosure 3 to show the unexpected effect of the present invention.

The prior art does not suggest the desirability of the claimed combination. The teaching or suggestions to make the claimed combination and the reasonable expectation of success are not found in the prior art. What problem would one skilled in the art be attempting to solve by combining the teachings of Kim et al. with Thei et al. or Prall et al?

As stated above the three criteria to establish a *prima facia* case of obviousness are not met by combining the teachings of the cited references.

It is believed that independent Claims 1, 9 and 16 are allowable and therefore dependent Claims 2-8, 8-15 and 17-20 are allowable as well.

Accordingly, reconsideration and examination of the present application is respectfully requested.

The application is now in condition for allowance. Allowance of the application at an early date is respectfully requested.

The Applicants reserve the right to seek protection for any unclaimed subject matter either subsequently in the prosecution of the present case or in a divisional or continuation application.

The Commissioner is authorized to charge any additional fees which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, then the Commissioner is authorized to treat this response as including

a petition to extend the time period pursuant to 37 CFR 1.136 (a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

I hereby certify that this correspondence is being deposited with the United States Post Office with sufficient postage as first class mail in an envelope addressed to: Commissioner of Patents, Washington, D.C., 20231 on

January 22, 2003
(Date of Deposit)

Richard P. Berg
(Name of Person Depositing)

(Signature)

January 22, 2003
(Date)

Respectfully submitted,

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Enclosures: Appendix A
Appendix B
Enclosures 1-3

## Appendix A

What is claimed is

1. A method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, comprising the steps of:

forming a nitride etching stop layer over the gate electrode and the semiconductor substrate;

forming an oxide insulating layer on the nitride etching stop layer; and

plasma-etching the oxide insulating layer by an etching gas containing $C_5F_8$ and $CHF_3$ so as to form a self-aligned contact hole between the pair of gate electrode.

2. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the oxide insulating layer is BPSG.

3. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the oxide insulating layer is silicon oxide formed by a reactive gas containing TEOS

4. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the nitride etching stop layer is silicon nitride.

5. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the nitride etching stop layer is silicon oxy-nitride.

## Appendix A

6. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the etching gas further comprises an inert gas.

7. A method of forming a self-aligned contact hole as claimed in Claim 6, wherein the inert gas is argon gas.

8. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the $C_5F_8/CHF_3$ mixture ratio of the etching gas is between 0.4 and 0.75.

9. A method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, comprising the steps of:

forming a nitride etching stop layer over the gate electrodes and the semiconductor substrate;

forming a oxide insulating layer on the nitride etching stop layer; and

plasma-etching the oxide insulating layer by an etching gas containing $C_4F_6$ and $CHF_3$ so as to form a self-aligned contact hole between the pair of gate electrode..

10. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the oxide insulating layer is BPSG.

11. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the oxide insulating layer is silicon oxide formed by a reactive gas containing TEOS

## Appendix A

12. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the nitride etching stop layer is silicon nitride. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the nitride etching stop layer is silicon oxy-nitride.

13. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the etching gas further comprises an inert gas.

14. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the etching gas further comprises an inert gas.

15. A method of forming a self-aligned contact hole as claimed in Claim 13, wherein the inert gas is argon gas.

## Appendix B

What is claimed is:

1. A method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, comprising the steps of:

forming a nitride etching stop layer over the gate electrode and the semiconductor substrate;

forming an oxide insulating layer on the nitride etching stop layer; and

plasma-etching the oxide insulating layer by an etching gas containing $C_5F_8$ and $CHF_3$ so as to form a self-aligned contact hole between the pair of gate electrode.

2. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the oxide insulating layer is BPSG.

3. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the oxide insulating layer is silicon oxide formed by a reactive gas containing TEOS.

4. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the nitride etching stop layer is silicon [ ]nitride.

5. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the nitride etching stop layer is silicon [ ]oxy-nitride.

6. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the etching gas further

## Appendix B

comprises an inert gas.

7. A method of forming a self-aligned contact hole as claimed in Claim 6, wherein the inert gas is argon gas.

8. A method of forming a self-aligned contact hole as claimed in Claim 1, wherein the $C_5F_8/CHF_3$ mixture ratio of the []etching []gas []is []between []0.4 []and []0.75.

9. A method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, comprising the steps of:

forming a nitride etching stop layer over the gate electrodes and the semiconductor substrate;

forming a oxide insulating layer on the nitride etching stop layer; and

plasma-etching the oxide insulating layer by an etching gas containing $C_4F_6$ and $CHF_3$ so as to form a self-aligned contact hole []between []the []pair []of []gate []electrode.[.]

10. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the oxide insulating layer is BPSG.

11. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the oxide insulating layer is silicon oxide formed by a reactive gas containing TEOS.

## Appendix B

12. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the nitride etching stop layer is silicon [ ]nitride.

13. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the nitride etching stop layer is silicon [ ]oxy-nitride.

14. A method of forming a self-aligned contact hole as claimed in Claim 9, wherein the etching gas further comprises an inert gas.

15. A method of forming a self-aligned contact hole as claimed in Claim 13, wherein the inert gas is argon gas.

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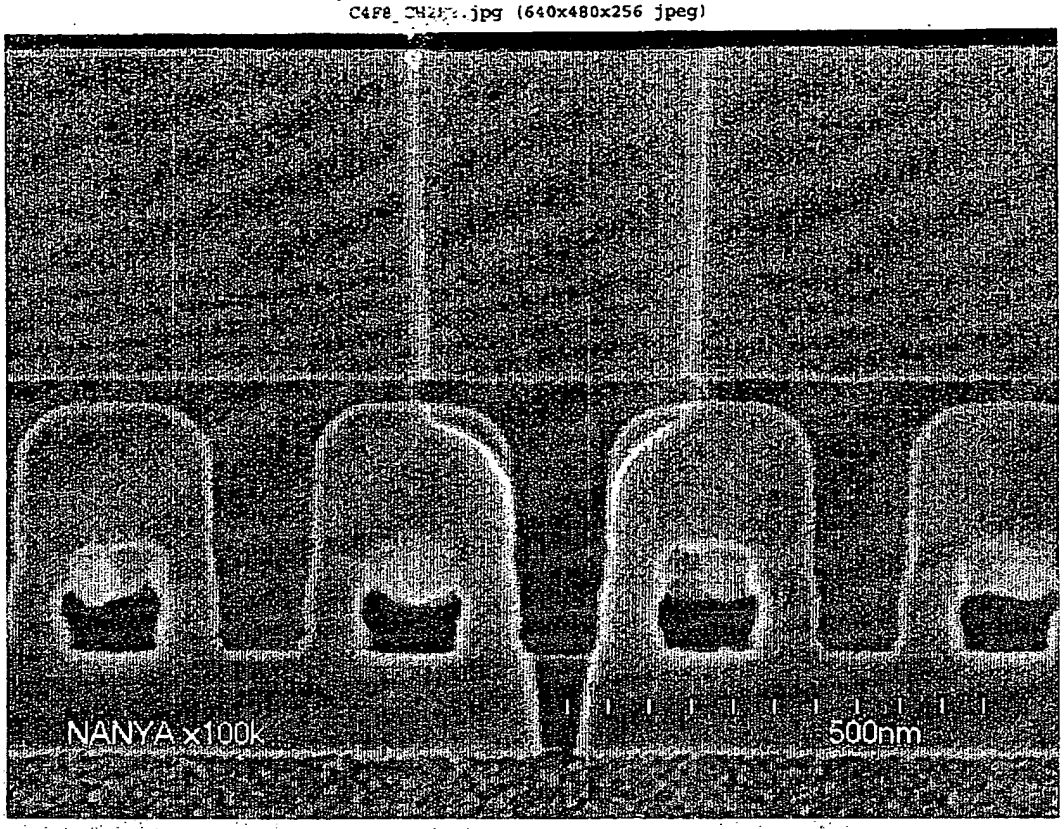

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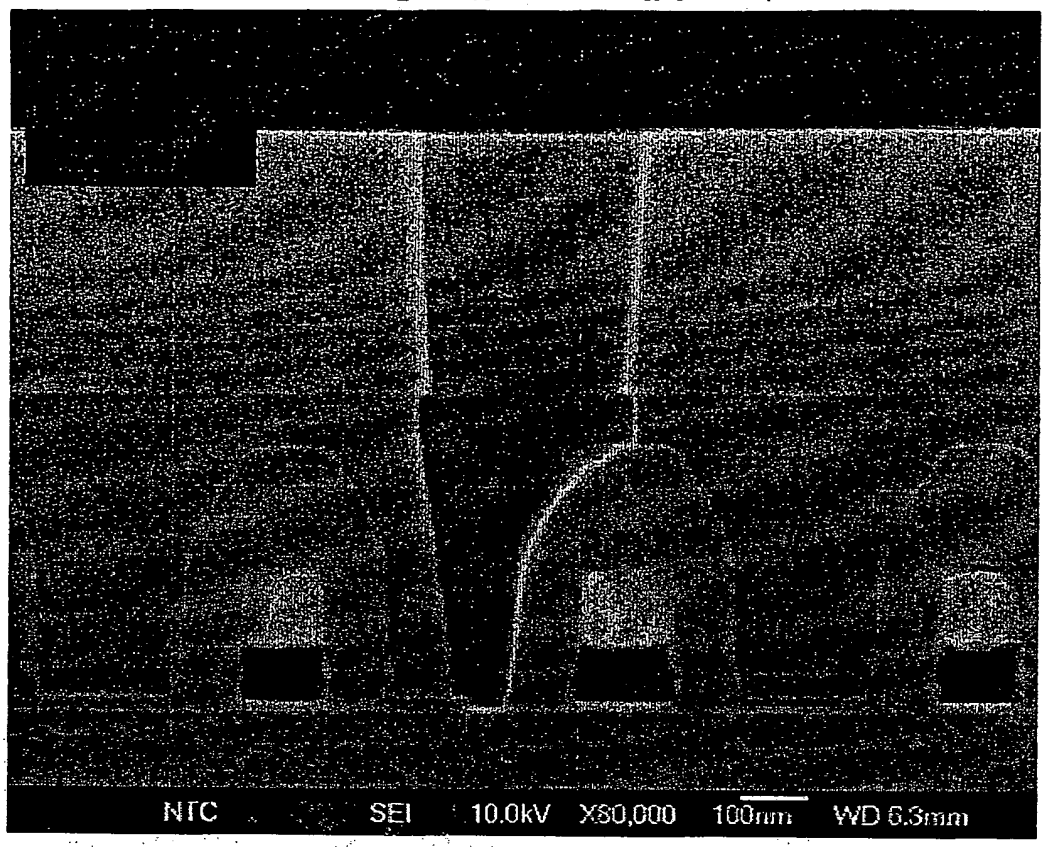

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